

The IR Properties of Ringed Galaxies and the IRAS Database

Final Technical Report

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Other Investigators: Dr. Deborah A. Crocker

Investigator Support:

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Student Support:

From July 1, 1991 to May 15, 1992, Mr. Fabio Bresolin was supported half-time by funding from the project. From May 15 to June 15, 1992, Ms. Lauren V. Jones was supported.

Scientific Progress:

Our study of the IRAS properties of ringed galaxies has been largely successful. We have identified what we think is the probable cause of the differences in the IRAS properties among non-interacting barred galaxies as the pattern speed of the bar. The key to identifying this parameter has been our focusing the study on outer-ringed galaxies where we know precisely what is present in the central regions (from available *BVI* CCD images in our library of images). The theory is that outer rings, through their morphology and other characteristics, can be identified with the outer Lindblad resonance, one of the major resonances in galaxy structure. Using a library of n-body simulations for comparison, we can reliably infer both low and high pattern speed galaxies from the appearance of outer rings and the existence of other ring features. It is clear that in some barred galaxies, the bar pattern speed is high enough to avoid an inner Lindblad resonance, hence such objects do not contain nuclear or circumnuclear star formation. The IRAS observations are most sensitive to nuclear star formation in early-type barred galaxies, and will thus select those barred galaxies where the pattern speed is low enough to allow an inner Lindblad resonance to exist. High pattern speed barred galaxies therefore weaken the correlation between bars and infrared excess. This finding helps to reconcile the inconsistent results found between different studies on the correlation between bars and far-IR emission.

We came to these conclusions through the study of the far IR-to-blue light ratio ($FIR/L(B)$) for a large sample of ringed barred and non-barred galaxies. We found correlations both between this ratio and the nuclear structure in the galaxy (red nucleus vs.

blue nuclear ring vs. blue nucleus) and also between this ratio and the type of outer ring structure. Blue nucleus galaxies had the largest FIR/L(B) ratio and red nucleus galaxies had the lowest, with many red nucleus galaxies not being detected at all. Blue nuclear rings galaxies had intermediate values. Outer ring type R1 galaxies correlated well with higher values of FIR/L(B) indicating a preference for blue nuclear rings or blue nuclei. Outer ring type R2 galaxies correlated well with low values of FIR/L(B) indicating a preference for red nuclei. The question became how did the nucleus and outer parts of the galaxy know about each other. Pattern speed seemed the obvious answer. Subsequent n-body simulations, mentioned above, confirmed this.

One test we had proposed and completed was a study of the consistency between different observers on the classification of barred galaxies. By comparing the morphological types in the Third Reference Catalogue of Bright Galaxies (RC3) with those in the Revised Shapley-Ames Catalogue (RSA), we find considerable inconsistency in the recognition of the bar characteristic. This is important for any study which focuses on the relationship between bars and far-IR emission. It certainly must also contribute to the confusion in conclusions of previous studies which compared IR emission from barred and non-barred galaxies.

The Catalogue of Southern Ringed Galaxies (CSRG), the main source of galaxies for our study, has been completed. We have extracted the necessary information from the Point Source Catalogue (PSC), ADDSCANS, and FRESCOS to incorporate IRAS data into the CSRG. For the study mentioned above we had data for 93 galaxies with known nuclear morphology. An additional 73 were taken from the CSRG for tests of unknowns. We applied to IPAC for ADDSCANS of 327 galaxies and FRESCOS for an additional 32. The remaining sources were taken from the PSC or the Faint Source Catalogue.

A recent Astrophysical Journal paper by Feigelson and Isobe covered some of the objectives of our original study. We have obtained a copy of their database and are also incorporating some of their data into the CSRG database. The Feigelson and Isobe galaxies are mostly from the northern hemisphere, however.

Preliminary results from our study were presented at a meeting entitled "Detection of Resonances in Spiral Galaxies" held at the Space Telescope Science Institute in Baltimore,

on June 29-30, 1992.

Publication of the results as an Astrophysical Journal Letter and a longer Astrophysical Journal paper are in preparation. In these papers we show the correlation between the FIR/L(B) ratio and outer ring type, relate this to the correlation between FIR/L(B) and the presence of a nuclear ring. We interpret this as an indicator that pattern speeds remain constant throughout the disk and furthermore, can be used to predict the existence of a nuclear ring almost without fail when FIR/L(B) and outer ring type are taken into consideration.